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(71) Applicants (*for all designated States except US*): SANDVIK AKTIEBOLAG [SE/SE]; S-811 81 Sandviken (SE). SMITH INTERNATIONAL, INC. [US/US]; 16740 Hardy Street, Houston, TX 77205 (US).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): EDERYD, Stefan [SE/SE]; Galärvägen 14, S-132 47 Saltsjö-Boo (SE). PACKER, Scott. M. [US/US]; 324 West 1570 North, Pleasant Grove, UT 84062 (US). RAI, Ghanshyam [US/US]; 10052 S. Rockview Circle, Sandy, UT 84042 (US). RODRIGUEZ, Arturo, A. [US/US]; 5660 Drake Hollow East, West Bloomfield, MI 48322 (US).

(74) Agent: TÅQUIST, Lennart; Sandvik Aktiebolag, Patent Dept., S-811 81 Sandviken (SE).

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(54) Title: CORROSION AND OXIDATION RESISTANT PCD/PCBN GRADES FOR WOODWORKING APPLICATIONS

(57) Abstract

A cutting tool for woodworking applications has a cemented carbide substrate and a hard layer bonded to the substrate at high temperature and high pressure, i.e. where diamond or cubic boron nitride is thermodynamically stable. The hard layer comprises polycrystalline diamond and/or polycrystalline cubic boron nitride, and a catalyst cobalt phase including adjuvant alloying materials for providing oxidation and corrosion resistance. Typical alloying elements include nickel, aluminum, silicon, titanium, molybdenum and chromium. The hard layer has an as-sintered surface and is only about 0.3 mm thick. An additional secondary phase including a carbide, nitride, carbonitride or oxycarbonitride of metals such as titanium may also be present in the PCD or PCBN layer.

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CORROSION AND OXIDATION RESISTANT PCD/PCBN GRADES FOR WOODWORKING APPLICATIONS

FIELD OF THE INVENTION

This invention relates generally to sintered polycrystalline abrasive compacts of diamond and cubic boron nitride for fabrication into cutting tools for woodworking applications.

More particularly, this invention relates to oxidation and corrosion resistant polycrystalline diamond and cubic boron nitride compacts with adjuvant alloying materials to the catalyst cobalt phase which form stable oxide, chloride and sulfide compounds.

BACKGROUND OF THE INVENTION

Reconstituted wood products, such as medium density fiberboard and chipboard, together with solid wood, are the main raw materials used to produce wood products for the furniture and housing industries.

In woodworking applications, the primary qualities desired for a polycrystalline PCD compact tool are abrasive wear resistance, thermal stability, high thermal conductivity, impact resistance and a low coefficient of friction in contact with the workpiece. Abrasive wear resistance has long been considered of primary importance in determining the suitability of a particular composition for woodworking purposes. Abrasion has been considered the primary mechanism for tool cutting edge degradation when machining reconstituted wood products.

However, we have found that degradation of the cutting edge of a PCD tool is accelerated by chemical attack of the cobalt phase through oxidation and corrosion, as the temperature increases during cutting operations. Over 213 different chemical compounds have

been identified as decomposition products during the machining of various solid woods. Reconstituted wood products comprise additional materials formed or added as an adjunct to the manufacturing process such as urea, formaldehyde, glue fillers, extenders, and possible flame retardant chemicals. Reconstituted wood products, therefore, produce even more decomposition products upon machining, some of which are chemically quite aggressive.

PCD cutting tools presently available to the woodworking industry are not adapted to resist these kinds of chemical attack. Chemical degradation of PCD tool edges is a two stage mechanism that is, generally, temperature dependent.

During the initial cutting period, temperatures are low typically in the range from about 300°C to 500°C. At these temperatures, wood decomposition products remain relatively stable and are introduced into the environment proximate to the cutting tool.

Highly corrosive forms of particularly, sulphur and chlorine containing compounds attack the cobalt phase that surrounds the PCD matrix, by forming cobalt chlorides and sulfides. These cobalt compounds are less thermodynamically stable and more easily eroded causing the cobalt to abrade away more quickly, resulting in accelerated wear.

During later, typically higher temperature cutting periods above about 500°C, sulphur and chlorine containing decomposition products are volatilized and thus removed from the region proximate to the cutting tool. However degradation of the cutting edge now proceeds by further corrosion/oxidation of the cobalt phase in air. Cobalt oxides are easily removed by mechanical abrasion, resulting in swift degradation of the sharpness of the cutting edge. An additional

disadvantage of presently available PCD cutting tools is that they are typically designed for use in machining metals rather than wood products. Moreover, the bulk physical characteristics of these prior art PCD metalworking tools make them less suitable for use as woodworking tools.

The periphery of these products are cut to the desired shape from a disc of a size about Ø50 mm by wire electrical discharge machining (EDM) and their surfaces are often lapped and polished with diamond wheels or electrical discharge grinding (EDG).

Although the prior art discloses the advantages of making a PCD compact using a variety of catalyst phase, it does not disclose a combination of these or other adjuvant materials in the appropriate amount to produce an improved polycrystalline PCD compact which is oxidation and corrosion resistant for woodworking applications. It is therefore highly desirable to provide a sintered polycrystalline PCD compact, comprising the use of various adjuvant materials that act to retard the oxidation and corrosion of the catalyst phase and impart to the sintered PCD compact the level of abrasive wear resistance, impact resistance, and stability needed to perform as a wood cutting tool.

BRIEF DESCRIPTION OF THE DRAWING

The drawing shows a side view of a simple cutting tool for use in woodworking.

SUMMARY OF THE INVENTION

A cutting tool for woodworking applications has a WC-Co cemented carbide substrate and a layer of polycrystalline diamond or polycrystalline cubic boron nitride bonded thereto at high temperature and high

pressure, i.e. where diamond or cubic boron nitride is thermodynamically stable. The hard layer comprises a cobalt catalyst phase including adjuvant alloying materials for providing oxidation and corrosion resistance. Typical alloying elements include nickel, aluminum, silicon, titanium, molybdenum and chromium.

An additional secondary phase including a carbide, nitride, carbonitride and/or oxycarbonitride of metals such as titanium may also be present in the hard layer.

Preferably, the hard layer has an as-sintered surface.

DETAILED DESCRIPTION

When creating a polycrystalline diamond (PCD) or polycrystalline cubic boron nitride (PCBN) compact for fabrication into a cutting tool for woodworking applications, it is enough that the edge of the tool contains a hard, corrosion and oxidation resistant layer comprising PCD or PCBN and a heat-resistant/wear-resistant hard material. Therefore, it is advantageous to form a composite compact which comprises a PCD or PCBN hard layer 10 and a WC-Co cemented carbide substrate 12 integral with the former. An exemplary tool as illustrated in the drawing comprises such a composite compact with a cutting edge 14 at one end of the superhard layer. The cutting tool may be attached as cutting elements in fluted cutters, routers, saws and the like.

While cubic boron nitride is the preferable high pressure boron nitride phase, the compacts may be made using wurzitic boron nitride or a mixture of cubic and wurzitic boron nitride as a starting material. Some hexagonal boron nitride may be included as a raw material for conversion to cubic boron nitride in the super pressure press.

PCD/PCBN composite compacts comprise a superhard layer preferably in the range from about 0.3 to 0.9 mm thick, most preferably about 0.3 mm for PCD and about 0.9 mm for PCBN.

The thickness of the cemented carbide substrate for a PCD compact is about 1.7 mm giving an overall thickness of about 2.0 mm and for a PCBN compact it is about 2.1 mm giving an overall thickness of about 3.0 mm. A cemented carbide substrate of a straight grade type with i.e. a typical composition of about 5% Co and WC is desirable since it has a high degree of hardness, heat conductivity and toughness. Alternatively substrates with corrosion resistant binder phase containing also Mo, Cr etc. can be used.

Various methods of making a composite compact comprising PCD or PCBN and a cobalt phase and sintered to cemented carbide are known. For example, U. S. Patent No. 5,326,380 to Yao, the disclosure of which is expressly incorporated herein by reference, describes a process for forming a PCBN compact wherein cubic and wurtzite boron nitride crystals are compacted into a preform, along with various adjuvant materials and placed onto a cemented carbide substrate and subjected to HPHT.

The diamond or cubic boron nitride grits of a grainsize 0.5-30μm are mixed with 10 to 20 weight-% catalyst metal phase powder including adjuvant alloying materials for providing oxidation and/or corrosion resistance and optionally 2-50 weight-%, preferally 2-20 weight-% of a powder comprising carbide, nitride, carbonitride or oxycarbonitride or boride containing hard material, preferably of the group IVb, Vb, and VIB transition metals of the periodic table, most preferably titanium carbonitride (TiCN) or titanium oxycarbonitride (TiCNO).

Cobalt may be present as an intermediate layer placed onto the cemented carbide substrate, in which case there is minimized infiltration of the cobalt from the substrate.

The adjuvant materials added to enhance the oxidation and/or the corrosion resistance of the compact include elements from groups IIIa, IVa and Va of the periodic table, or mixtures and alloys thereof for example aluminum and silicon. Elements from groups IVb, Vb, and VIB of the periodic table or mixtures and alloys thereof elements, such as tungsten, titanium, chromium, molybdenum, nickel may also be added. The adjuvants need not be added in elemental form and are conveniently added in the form of alloys or compounds that melt or dissolve into the cobalt phase. Adjuvants may be introduced in the form of atomised cobalt alloy powder. An alloy of a group IIIa element and a group VIII metal, in particular, Co_2Al_9, $NiAl_3$, NiAl and Fe-Al compounds, or mixtures thereof, is preferred.

During the sintering at HPHT conditions the binder phase melts in the cemented carbide and infiltrates throughout the diamond or cBN containing layer and sinters the superhard material layer. The adjuvant materials dissolve into the cobalt-rich liquid phase, thus alloying with the cobalt. The bonding is intercrystalline between the diamond or CBN crystals.

The finished compact is either a circular or rectangular wafer comprising a PCD or PCBN layer sintered to a cemented carbide substrate. The periphery of a composite compact is cut into the desired shape of the finished cutting tool by electrical discharge machining (EDM). What is to be the leading or cutting surface of the tool is tapered, by bevelling, to provide a taper angle between the clearance face and the rake face of about 50-75° preferably about 60°. Preferably,

the top surface of the PCD or PCBN hard layer of the cutting tool remains "as sintered" in the completed cutting tool with only the clearance face ground to provide the proper taper angle. Forming a cutting tool with an "as sintered" hard surface results in an appreciable reduction in the cost of the cutting tool without negative affecting the initial wear of the cutting tool.

The surface features of the PCD or PCBN "as sintered" hard face are determined by the surface against which it is formed. In the compact manufacturing process the face of the preferred niobium can against which the compact is pressed, is emulated by the hard layer. After sintering NbC has been formed and presents a smooth hard surface layer of the compact with little or no irregularities.

The thickness of the PCD or PCBN hard layer according to the invention also allows the tool surface to remain "as sintered". Conventional compacts are manufactured with hard layer thicknesses of about 0.9 mm in order to provide sufficient bulk material in the hard layer to resist high stress forces during cutting and avoid breakage. When such a hard layer is formed on a cemented carbide substrate, the top surface of the compact often bows away from flatness because of the thermal expansion difference between the PCD or PCBN and the cemented carbide substrate, requiring the top surface of the cutting tool to be ground back to flatness by, for example, electrical discharge grinding (EDG). A thin layer according to the invention comprises insufficient bulk material to cause bowing in response to material thermal expansion mismatch between the hard layer and the cemented carbide substrate. The top surface of a cutting tool with such a layer need not,

therefore be ground or lapped to achieve the desired flatness.

A compact according to the invention includes polycrystalline diamond (PCD) or polycrystalline cubic boron nitride (PCBN) as a first phase, a second phase which is a carbide, nitride, boride, carbonitride or oxycarbonitride containing hard material of the group IVb, Vb, and VIB transition metals and a third phase mainly composed of cobalt alloy further including adjuvant materials for oxidation and corrosion resistance. The second and third phase materials easily deform under super-pressures to form a densely compacted powder body before the appearance of the liquid phase. As a result, there will occur only minimal permeation of the liquid phase of the cemented carbide substrate into the superhard layer during sintering under super-pressures.

Particularly the addition of alloying elements from the group IVb, Vb, and VIB transition metals to the cobalt phase seem to further enhance both the oxidation and corrosion resistance of the cobalt phase. Titanium, chromium, molybdenum, and the like, all form stable sulfide, chloride, and oxide compounds at lower temperatures than cobalt. Probably wood decomposition products such as sulphur and halide compounds, therefore preferentially bond to the adjuvant material, thus allowing the cobalt to retain its integrity.

EXAMPLES

Six PCD and PCBN cutting tools of different grades were prepared to determine their suitability for cutting medium density fiberboard (MDF).

Two 700 grade PCD tools were prepared, each with a different PCD layer thickness and top surface finish. The 700 grade PCD material has relatively large diamonds

with average particle sizes of about 28 µm. The diamond grains are mixed with about 3 percent by weight titanium oxycarbonitride and placed on a WC-5%Co cemented carbide substrate. Cobalt infiltrates from the cemented carbide substrate during the HPHT process. The final PCD has about 15% by weight metal phase and a typical composition comprises about 1 percent titanium, about 4 percent tungsten and about 11 percent cobalt.

One tool was formed with a 700 grade PCD hard layer of about 0.6 mm thickness. The hard layer top surface was subsequently polished to a mirror finish in a well known manner with a Coburn machine. The second 700 grade PCD tool was formed with a PCD hard layer of about 0.3 mm thickness, whose top surface was allowed to remain as-sintered.

Two 300 grade PCD tools were prepared, again each with a different PCD layer thickness and top surface finish. In contrast to 700 grade, the 300 grade PCD material comprises substantially smaller diamond particles with average particle sizes of, typically, about 5 µm. The metal content, largely infiltrated from the carbide substrate, is typically 17.3% by weight. An exemplary analysis of the metal phase is 3.2% tungsten, 1.6 % titanium and 12.5 % cobalt (relative to the total weight of the PCD material). One tool was formed with a PCD hard layer of about 0.6 mm thickness, the top surface of which was subsequently mirror polished. The second 300 grade PCD tool was formed with a PCD hard layer of about 0.3 mm thickness, whose surface was again allowed to remain as-sintered.

Two additional tools were also prepared from PCBN grades, identified herein as MN-90, to determine the suitability of PCBN materials for woodworking applications. As for the PCD grades, the hard layer was formed with different thicknesses. The top surface of

each tool was lapped from its as-sintered thickness to its final desired value; a standard 0.9 mm thickness in the first case, a 0.3 mm thickness in the second.

The MN-90 grade PCBN material comprises about 95% polycrystalline cubic boron nitride (PCBN) and about 5% Co_2Al_9 on a cemented carbide substrate. Cobalt infiltrates from the substrate during sintering yielding a metal phase of about 22% by weight.

Alternatively, a MN-50 PCBN material, comprising about 60% CBN, 32% $Ti(O,C,N)_z$ and 8% Co_2Al_9 may be substituted for MN-90. The $Ti(O,C,N)_z$ material is referred to as a titanium oxycarbonitride. The material composition may be high in nitrogen, low in carbon, and comprise about 20 atomic percent oxygen. However, the material is not stoichiometric. Z is typically less than its stoichiometric value.

Further details of the composition of MN-90 PCBN material are set forth in U.S. Patent 5,271,749, assigned to the same assignee as the present application, the disclosure of which is expressly incorporated herein by reference.

Two cutting tools of each type were prepared for testing on medium density fiberboard (MDF). Each of the cutting tools were fabricated as regular cutters with a length of about 22 mm, a width of about 9.5 mm and a taper angle of about 65^{o} along the clearance face. The tool shape was defined by wire EDM cutting. Each tool, therefore, cuts with only an EDM quality edge.

Each tool was mounted, in turn, on a tool holder on a lathe with a mechanized feed system configured to press the tool against the edge of a rotating MDF disk about 2.5 cm thick and 45 cm in diameter. The tool holder included two transducers for monitoring the cutting forces as seen by the tool the parallel force, tangential to the radius of the MDF disk (the force

pushing down on the tool), and the normal force required to push the tool in the radial direction toward the center of the MDF disk at the feed rate.

All of the tests were conducted with a feed rate of about 0.2 mm per revolution, 330 disk revolutions per minute, 15° tool rake angle, and 10° tool clearance angle. The MDF disks were from the same material lot and each disk represented about 215 m of cutting distance. The tools each cut a total of about 1300 m of MDF.

The normal and parallel forces were measured, with the results, expressed in pounds, tabulated in Table 1.

TABLE 1

Test No.	Type	Initial Avg. Normal Force	Final Avg. Normal Force	Initial. Avg. Parallel Force	Final Avg. Parallel Force
1	PCD 700 Grade 0.6 mm, Polished	8.8	17.5	13.8	17.3
2	PCD 700 Grade 0.3 mm, As Sintered	17.0	22.5	16.5	20.3
3	PCD 300 Grade 0.6 mm, Polished	7.0	14.3	12.3	17.3
4	PCD 300 Grade 0.3 mm, As Sintered	9.8	14.5	14.5	17.8
5	PCBN MN-90 Grade 0.9 mm, Lapped	14.8	17.0	16.0	18.0
6	PCBN MN-90 Grade 0.3 mm, Lapped	12.3	16.8	15.5	17.0

Inspection of the test results set forth in Table 1 indicates that the 300 grade, 0.6 mm PCD tool with a polished surface finish(Test No.3), returned the lowest overall cutting forces. However, the 300 grade, 0.3 mm "as sintered" PCD tool (Test No.4) performed equally

well. The final force values increased little over the initial force values, indicating that the cutting edges retained their sharpness and experienced little wear over the course of the test. Moreover, the PCBN grades (Test No.5 and 6), of both thicknesses returned test results indicating their suitability for woodworking applications.

Suitability for woodworking requires the normal force to remain less than the parallel force over the course of the test. When the requirement is met, it indicates the tool is cutting the particle board material. When the normal force exceeds the parallel force, it indicates the tool is "plowing" the material rather than cutting. Inspection of the cutting force data in Table 1 shows the suitability of the tested grades for woodworking, except the 700 grade PCD cutting tools (Test No 1 and 2). The plowing mode cross-over, where the normal force exceeds the parallel force, occurred early in the testing cycle for these grades and was maintained throughout the course of the test.

A second test was performed, under the same conditions as the first, on the PCD 300 grade, 0.3 mm, "as sintered" tool and the PCBN MN-90 grade, 0.9 mm, lapped tool. The tools were, however, provided with a finish ground edge, in contrast to the EDM machined edges of the preceding test. During finish grinding, 0.15 mm of material was removed from the tapered clearance faces of each tool.

The results of the second test are summarized in Table 2.

Table 2

Test No.	Type	Initial Avg. Normal Force	Final Avg. Normal Force	Initial Avg. Parallel Force	Final Avg. Parallel Force
1	PCD 300 Grade 0.3 mm, As Sintered	12.0	14.0	15.0	16.5
2	PCBN MN-90 Grade 0.9 mm, Lapped	12.0	13.0	14.0	15.5

Finish grinding, as indicated by comparing the results of Table 2 with the results of Table 1, improves the performance of each of the tools. Neither the normal force nor the parallel force had particularly low initial values, but the difference between the initial force value and final force value markedly improved, in both cases, illustrating a substantial reduction in wear.

It is clear, from the cutting force data shown in Table 1 and Table 2, that cutting tools suitable for woodworking applications may be fabricated from composite PCD compacts having "thin" PCD hard layers, preferably about 0.3 mm thick, and "as sintered" top surfaces. Moreover, suitable woodworking cutting tools may be fabricated from PCBN composite compacts having a PCBN hard layer thickness of from about 0.3 mm to about 0.9 mm. Suitable tools may be prepared with wire EDM machined clearance face edges, for the lowest manufacturing cost, or with a finish ground clearance edge.

The resulting cutting tools are fabricated from PCD and/or PCBN compacts possessing advantageous qualities not found simultaneously in the prior art; namely, (1) a significantly lower level of residual internal stress resulting from a substantially thinner PCD or PCBN hard

layer, resulting in high resistance to supporting phase erosion by abrasive materials, (2) a significantly lower manufacturing cost due, in part, to the "as sintered" surface for PCD grades, and the reduced thickness of the hard layer for PCD and PCBN grades, (3) high wear resistance under aggressive wood cutting conditions, (4) high thermal stability of the supporting phase, (5) low coefficient of friction, and (6) lack of chemical or metallurgical reaction with the workpiece through oxidation and corrosion resistance.

It is possible within the scope of this invention to practice a wide variety of compositions and temperature and pressure conditions in cycles which will achieve the same objective as these examples, and the foregoing examples are designed to be illustrative rather than limiting. Since many such variations may be made, it is to be understood that within the scope of the following claims, this invention may be practised otherwise than specifically described.

CLAIMS

1. A cutting tool adapted for woodworking applications comprising:

a cemented carbide substrate; and a hard layer bonded to the substrate at high temperature and high pressure, the hard layer comprising:

one of a material selected from the group consisting of polycrystalline diamond and/or polycrystalline cubic boron nitride, and a catalyst metal phase including adjuvant alloying materials for providing oxidation and/or corrosion resistance.

2. A cutting tool according to claim 1 further comprising a secondary phase including a carbide, nitride, carbonitride or oxycarbonitride containing hard material.

3. A cutting tool according to claim 2 wherein the carbide, nitride, carbonitride or oxycarbonitride containing hard material comprises at least one material selected from the group of carbides, nitrides, carbonitrides and oxycarbonitrides of transition metals from groups IVb, Vb and VIB from the periodic table.

4. A cutting tool according to claim 3 wherein the hard material is selected from the group consisting of titanium carbonitride and titanium oxycarbonitride.

5. A cutting tool according to claim 1 wherein the catalyst phase comprises cobalt and a corrosion and/or oxidation resistant adjuvant alloying material.

6. A cutting tool according to claim 5 wherein the corrosion and/or oxidation resistant adjuvant alloying material is at least one material selected from the group consisting of elements, alloys, and mixtures of group IVb, Vb and VIB transition metals from the periodic table.

7. A cutting tool according to claim 6 wherein the corrosion/oxidation resistant adjuvant alloying material

is at least one material selected from the group consisting of titanium, chromium and molybdenum.

8. A cutting tool according to claim 6 wherein the corrosion/oxidation resistant adjuvant alloying material is at least one material selected from the elements in groups IIIa, IVa, and Va of the periodic table and alloys, compounds, and mixtures thereof.

9. A cutting tool according to claim 7 wherein the oxidation resistant adjuvant alloying material is at least one material selected from the group consisting of aluminum containing materials and silicon containing materials.

10. A cutting tool according to claim 1 wherein the catalyst phase comprises cobalt and at least one material selected from the group nickel, aluminum, silicon, titanium, molybdenum and chromium.

11. A cutting tool according to claim 1 wherein the hard layer has a thickness of about 0.3 mm and an as-sintered surface.

12. A cutting tool adapted for woodworking applications comprising:

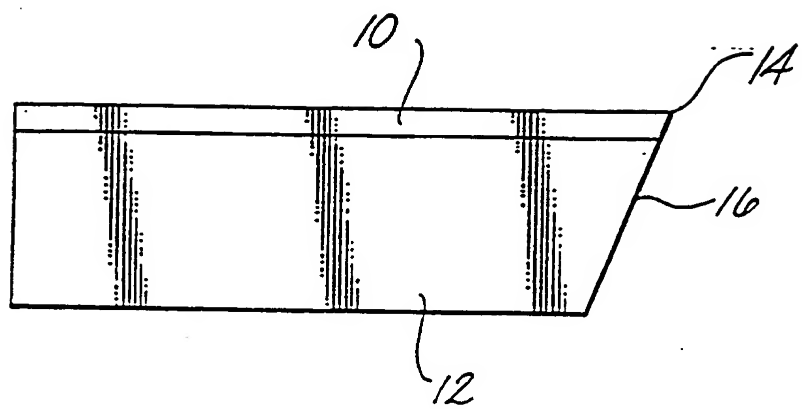
a cemented carbide substrate; and a hard layer bonded to the substrate at high temperature and high pressure, the hard layer comprising:

one of a material selected from the group consisting of polycrystalline diamond and/or polycrystalline cubic boron nitride, and a metal catalyst phase; and a cutting edge adjacent a face at an acute angle to the substrate and hard layer; and wherein the hard layer has an as-sintered surface.

13. A cutting tool according to claim 12 wherein the hard layer has a thickness of about 0.3 mm.

14. A cutting tool according to claim 12 wherein the catalyst phase comprises cobalt and at least one

material selected from the group consisting of nickel, aluminum, silicon, titanium, molybdenum and chromium.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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/00645

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B27G 13/00, C22C 29/00, C22C 29/08, C23C 24/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5326380 A (XIAN YAO ET AL), 5 July 1994 (05.07.94), column 3, line 45 - column 4, line 21 --	1-14
Y	WO 9402297 A1 (SANDVIK AB), 3 February 1994 (03.02.94), page 2, line 30 - page 3, line 16 --	1-14
Y	WO 8002569 A1 (SANDVIK AKTIEBOLAG), 27 November 1980 (27.11.80), page 5, line 1 - line 28; page 22, line 34 - page 27, line 4 --	1-14

[X] Further documents are listed in the continuation of Box C.   [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
27 August 1996	29 -08- 1996
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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E,X	WO 9616194 A1 (SANDVIK AB), 30 May 1996 (30.05.96), page 2, line 27 - page 3, line 32 --	1-14
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A	DE 3103351 C2 (SUMITOMO ELECTRIC INDUSTRIES, LTD.), 21 May 1992 (21.05.92), claims 1,2 --	1-14
A	DE 2919375 C2 (SUMITOMO ELECTRIC INDUSTRIES, LTD.), 26 June 1986 (26.06.86), column 1, line 1 - column 2, line 17 -- --------	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/96

International application No.
PCT/SE 96/00645

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		AU-A- 1320595	10/07/95
		AU-A- 1031295	06/06/95
WO-A1- 9402297	03/02/94	NONE	
WO-A1- 8002569	27/11/80	AT-E,T- 9169	15/09/84
		EP-A,B- 0028620	20/05/81
		SE-B,C- 420844	02/11/81
		SE-A- 7904331	18/11/80
		US-A- 4497660	05/02/85
US-A- 5271749	21/12/93	NONE	
WO-A1- 9616194	30/05/96	SE-A- 9404019	19/05/96
DE-A1- 3939809	06/06/91	NONE	
DE-C2- 3103351	21/05/92	NONE	
DE-C2- 2919375	26/06/86	GB-A,B- 2021154	28/11/79
		JP-C- 1191333	29/02/84
		JP-A- 54149308	22/11/79
		US-A- 4293618	06/10/81
		US-A- 4442180	10/04/84